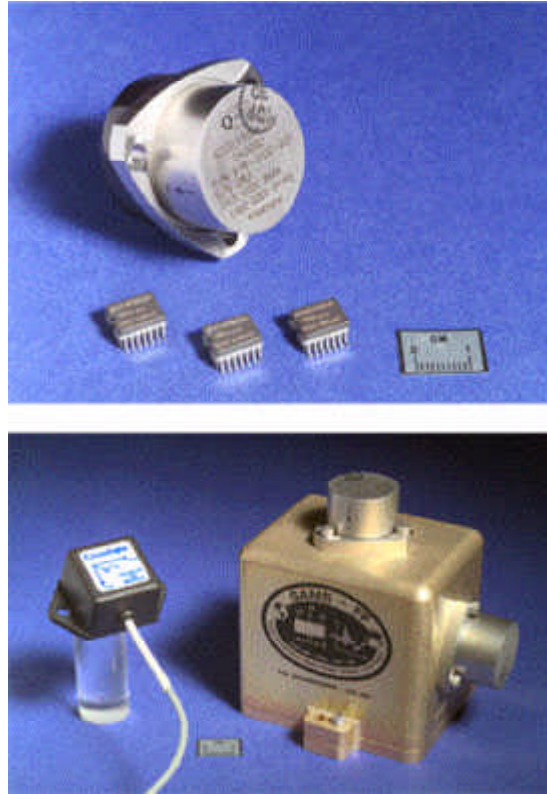


Advanced Microgravity Acceleration Measurement Systems Being Developed



Size and volume were greatly reduced with the MEMS accelerometer. Top: Traditional force-balance accelerometer used for microgravity measurements. Center: MEMS accelerometer. Bottom: MEMS reduces the size of a triaxial accelerometer. Left: MEMS-based triaxial sensor package. Right: SAMS triaxial sensor developed specifically for microgravity-level measurements.

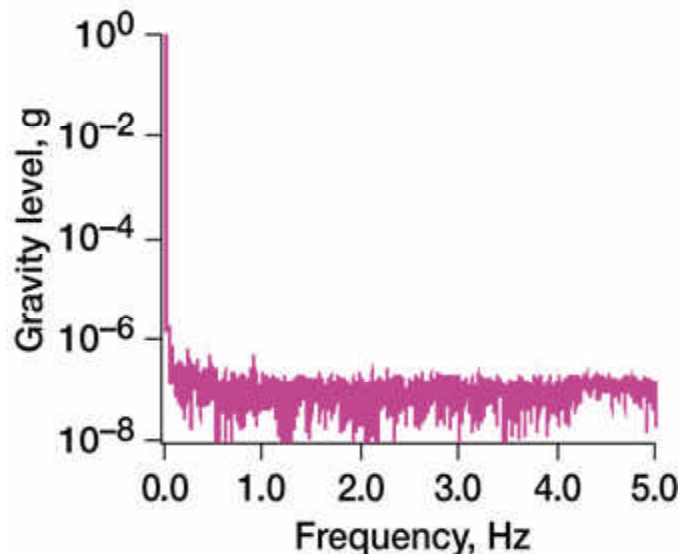
The Advanced Microgravity Acceleration Measurement Systems (AMAMS) project at the NASA Glenn Research Center is part of the Instrument Technology Development program to develop advanced sensor systems. The primary focus of the AMAMS project is to develop microelectromechanical (MEMS) acceleration sensor systems to replace existing electromechanical-sensor-based systems presently used to assess relative gravity levels aboard spacecraft. These systems are used in characterizing both vehicle and payload responses to low-gravity vibroacoustic environments. The collection of microgravity acceleration data has cross-disciplinary utility to the microgravity life and physical sciences and the structural dynamics communities. The inherent advantages of semiconductor-based systems are reduced size, mass, and power consumption, while providing enhanced stability.

A market survey was conducted to examine the state of the art in MEMS accelerometers, focusing on the requirements for making low-gravity, high-resolution measurements. From

this survey, the most suitable sensors were selected, and MEMS accelerometers in various stages of development have been received from vendors. In addition, appropriate signal-conditioning circuitry has been developed for the best performing sensors to facilitate benchtop and development testing. The goal of this first stage of testing is to demonstrate the capability to measure microgravity ($10^{-6}g$) levels during operations below 10 Hz. This frequency range is significant since the structural modes (when the structure rings) for the shuttles and the International Space Station are approximately 4.7 and 3.2 Hz, respectively.

The initial testing results demonstrated that several of the developmental MEMS sensors have the required sensitivity. This is significant since most of the commercial sensors that were tested were sensitive to only measured levels in the milli-g ($10^{-3}g$) range.

Further testing will be conducted with the chosen sensors to characterize their operational capabilities beyond the 1 to 10 Hz range. Also, a prototype Triaxial Sensor Head will be designed and fabricated as a step toward space flight hardware. The Triaxial Sensor Head design requires an enclosure with three sensors that are mounted triaxially and integrated with low-noise signal-conditioning circuitry and a computer interface--all packaged into a compact size suitable to operate successfully on long-duration space flights. Once a prototype is completed, computer algorithms will be developed to process and display the data.



Noise floor testing of one of the development MEMS accelerometers. This graph demonstrates the ability to measure lower than $10^{-6}g$ during operation below 5 Hz.

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Programs/Projects: Microgravity Science